TM-919
2972.000

Fermilab

A POSSIBLE OPERATION OF THE N-30 DICHROMATIC TRAIN AT 420 GEV FOR TEVATRON

S. MORI

November 5, 1979

The present N-30 dichromatic train was designed to run at the maximum tune of 350 GeV for the incident proton energy of 500 GeV.[1] This report discusses the possibility that the N-30 train can be upgraded to run at the tune of 420 GeV for the Tevatron. All the magnets of the N-30 train except for trim magnets are of main ring type and can be energized up to 7000 Amperes.[2] The present power supplies which can provide the maximum current of about 5000 Amperes must be modified. The avarage total power of the system for 420 GeV operation will be less compared to the present operation because of a longer cycle time for Tevatron.

Figures 1 and 2 show computed neutrino and antineutrino fluxes for a tune of 420 GeV at the incident proton energies of 800 GeV and 1000 GeV. Also shown are computed fluxes for a tune of 200 GeV at 400 GeV. The fluxes were computed by the NUADA program[3] for a detector radius of 1 meter at the 15' Bubble Chamber. Stefanski-White's parametrization[4] was used for particle production. Wrong sign backgrounds for the 420 GeV tune are expected to be similar to those at lower energy tunes which can be found in Reference 1. Table I summarizes relative event rates normalized to the rate for the tune of 200 GeV at 400 GeV.[5]

Neutrino spectra as a function of the detector radial intervals for the tune of 420 GeV at 1000 GeV are shown in Figure 3. The energy resolution of neutrinos from the kaon decay is roughly 10%. It must be pointed out that the neutrino energy resolution becomes more sensitive to the angular divergence of the secondary beam at higher energy tunes. Figures 4 and 5 show the energy resolution

Table I. Event Ratios Of The N-30 Dichromatic Train.

Tune/Proton Energy (GeV)	Neutrino	Antineutrino
200/400	1.0	0.14
420/800	2.3	0.23
420/1000	4.1	0.54

of neutrinos from the kaon decay as functions of the detector radius, momentum resolution and angular divergence of the kaon beam for tunes of 400 GeV and 700 GeV. The angular divergence of the N-30 train is about 0.1 mrad. Therefore, for higher energy tunes ($\gtrsim$600 GeV) a new design which minimizes the angular divergence of the secondary beam is required.[6]

Thermal stresses inside the magnet absorbers due to the beam are proportional to energy deposition of the beam.[7] Therefore, they are roughly proportional to the total beam power, i.e. the product of the energy and number of the incident protons. The proper operational limitations can be established from experiences of the present run. For the tune of 420 GeV at 800 GeV and 1000 GeV the primary proton beam will be dumped in the second quadrupole magnet (Q-2) absorber for the antineutrino beam and in the second dipole magnet (D-2) absorber for the neutrino beam. The D-2 absorber can have a smaller aperture[8] and no remote adjustment of the magnet position is required. Potential magnet failures due to radiation damages are expected for the above two magnets and the first dipole magnet (D-1) due to scattering from the target.[9]

In conclusion the upgrading of the N-30 dichromatic train to 420 GeV for Tevatron seems to be very attractive to the 15' Bubble Chamber run. Dichromatic beams which will be built for higher energy tunes ($\gtrsim$600 GeV) will have limited neutrino fluxes at lower energy tunes ($\lesssim$500 GeV).

References

1. D. Edwards, S. Mori, and S. Pruss, 350 GeV/c Dichromatic Neutrino Target Train, TM-661, May 1976.
2. T. Toohig, Fermilab Magnets, Power Supplies, And Auxiliary Devices: Technical Data, TM-632, December 1975.
3. D. C. Carey and V. A. White, Fermilab Internal Report, NUADA, June 1975.
4. R. Stefanski and H. White, Jr., Neutrino Flux Distributions, FN-292, May 1976.
5. A measured event rate for a tune of 200 GeV at 400 GeV for the N-30 dichromatic train is about 1/40 event per 10^{13} incident protons for the 15' Bubble Chamber filled with heavy neon mix.
6. L. Stutte, A Possible Dichromatic Neutrino Beam For A 1 TeV Accelerator, TM-841, January 1979.
7. S. Mori and H. Stredde, Magnet Beam Absorbers Of The 350 GeV/c Dichromatic Train, TM-761, January 1978.
8. We have a spare magnet with a smaller aperture absorber which meets the specifications for the D-2 for the 420 GeV tune.
9. S. Mori, Radiation Damages On Magnet Coils Of The 350 GeV/c Dichromatic Train, February 1978.

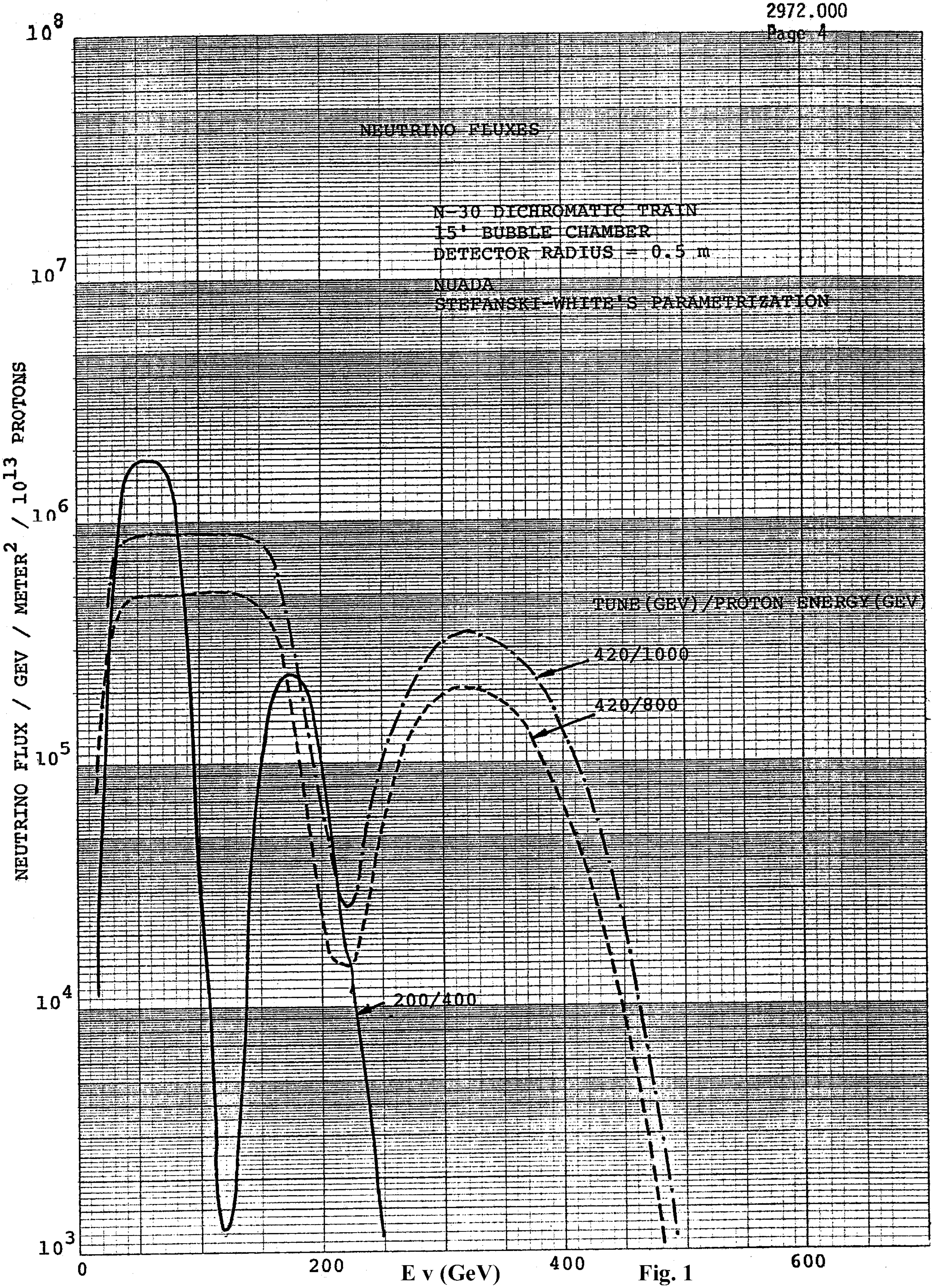

NEUTRINO FLUXES
N-30 DICHROMATIC TRAIN
15' BUBBLE CHAMBER
DETECTOR RADIUS = 0.5 m
NUADA
STEFANSKI-WHITE'S PARAMETRIZATION
TUNE(GEV)/PROTON ENERGY(GEV)
420/1000
420/800
200/400
NEUTRINO FLUX / GEV / METER^2 / 10^{13} PROTONS
10^8
10^7
10^6
10^5
10^4
10^3
0
200
400
600
E ν (GeV)

Fig. 1

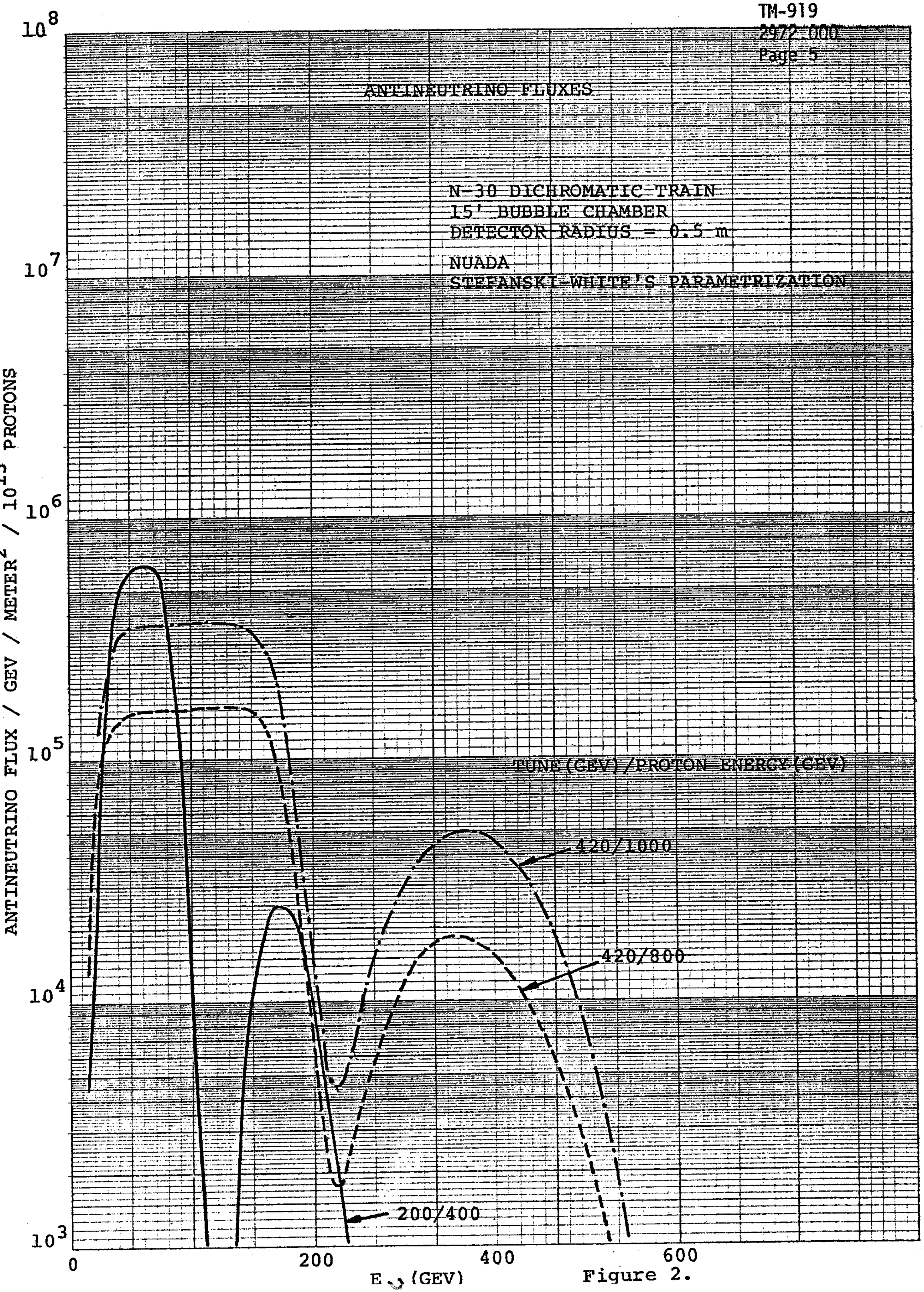
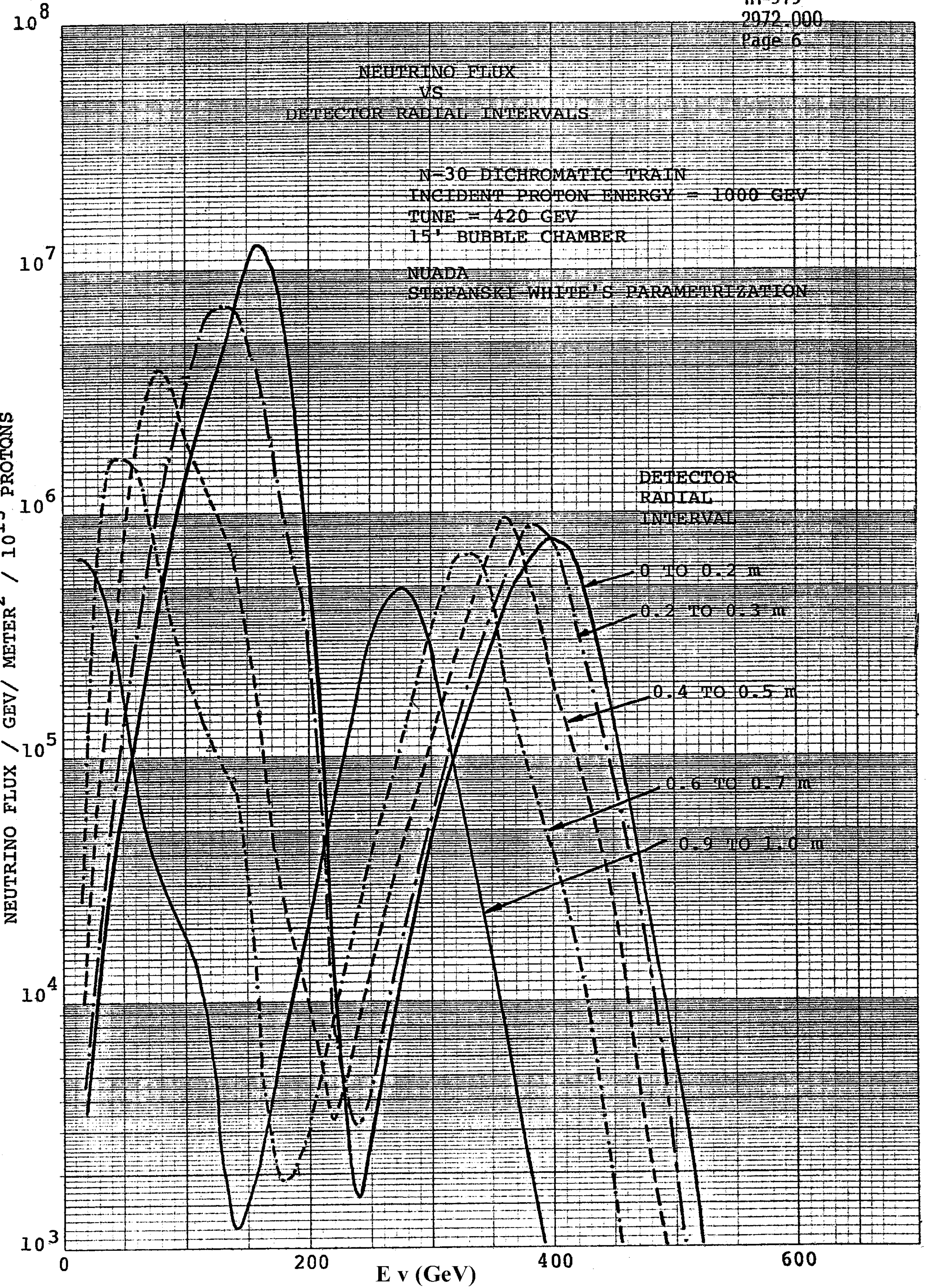

ANTINEUTRINO FLUXES
N-30 DICHROMATIC TRAIN
15' BUBBLE CHAMBER
DETECTOR RADIUS = 0.5 m
NUADA
STEFANSKI-WHITE'S PARAMETRIZATION
TUNE(GEV)/PROTON ENERGY(GEV)
420/1000
420/800
200/400
10^8
10^7
10^6
10^5
10^4
10^3
ANTINEUTRINO FLUX / GEV / METER^2 / 10^{13} PROTONS
0
200
400
600
E_ν (GEV)

Figure 2.


NEUTRINO FLUX
VS
DETECTOR RADIAL INTERVALS
N-30 DICHROMATIC TRAIN
INCIDENT PROTON ENERGY = 1000 GEV
TUNE = 420 GEV
15' BUBBLE CHAMBER
NUADA
STEFANSKI-WHITE'S PARAMETRIZATION
DETECTOR
RADIAL
INTERVAL
0 TO 0.2 m
0.2 TO 0.3 m
0.4 TO 0.5 m
0.6 TO 0.7 m
0.9 TO 1.0 m
10^8
10^7
10^6
10^5
10^4
10^3
0
200
400
600
NEUTRINO FLUX / GEV/ METER^2 / 10^{13} PROTONS
E ν (GeV)

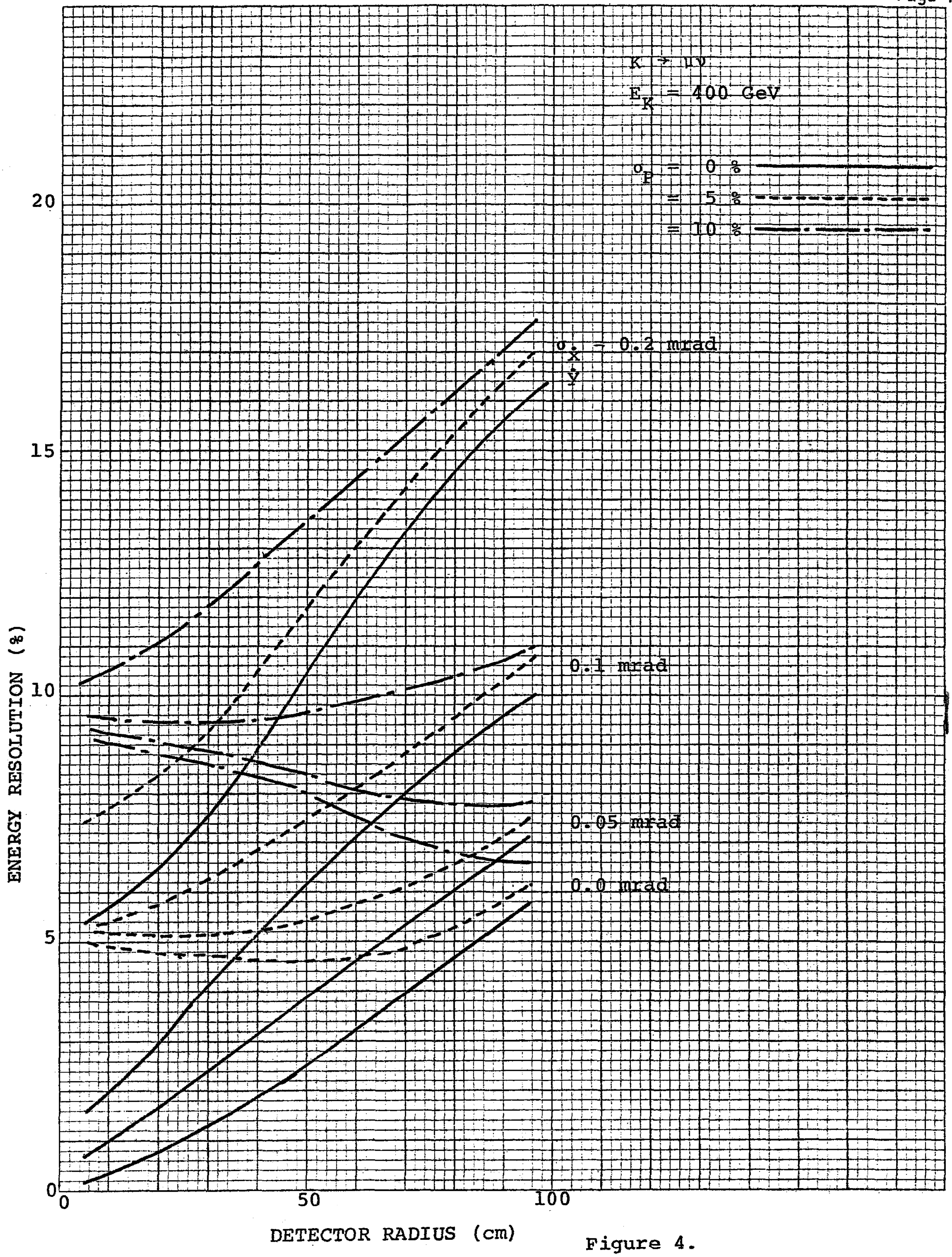

K → μν
E_K = 400 GeV
σ_P = 0 %
= 5 %
= 10 %
$\sigma_{x,y}$ = 0.2 mrad
0.1 mrad
0.05 mrad
0.0 mrad
ENERGY RESOLUTION (%)
0
5
10
15
20
0
50
100
DETECTOR RADIUS (cm)

Figure 4.

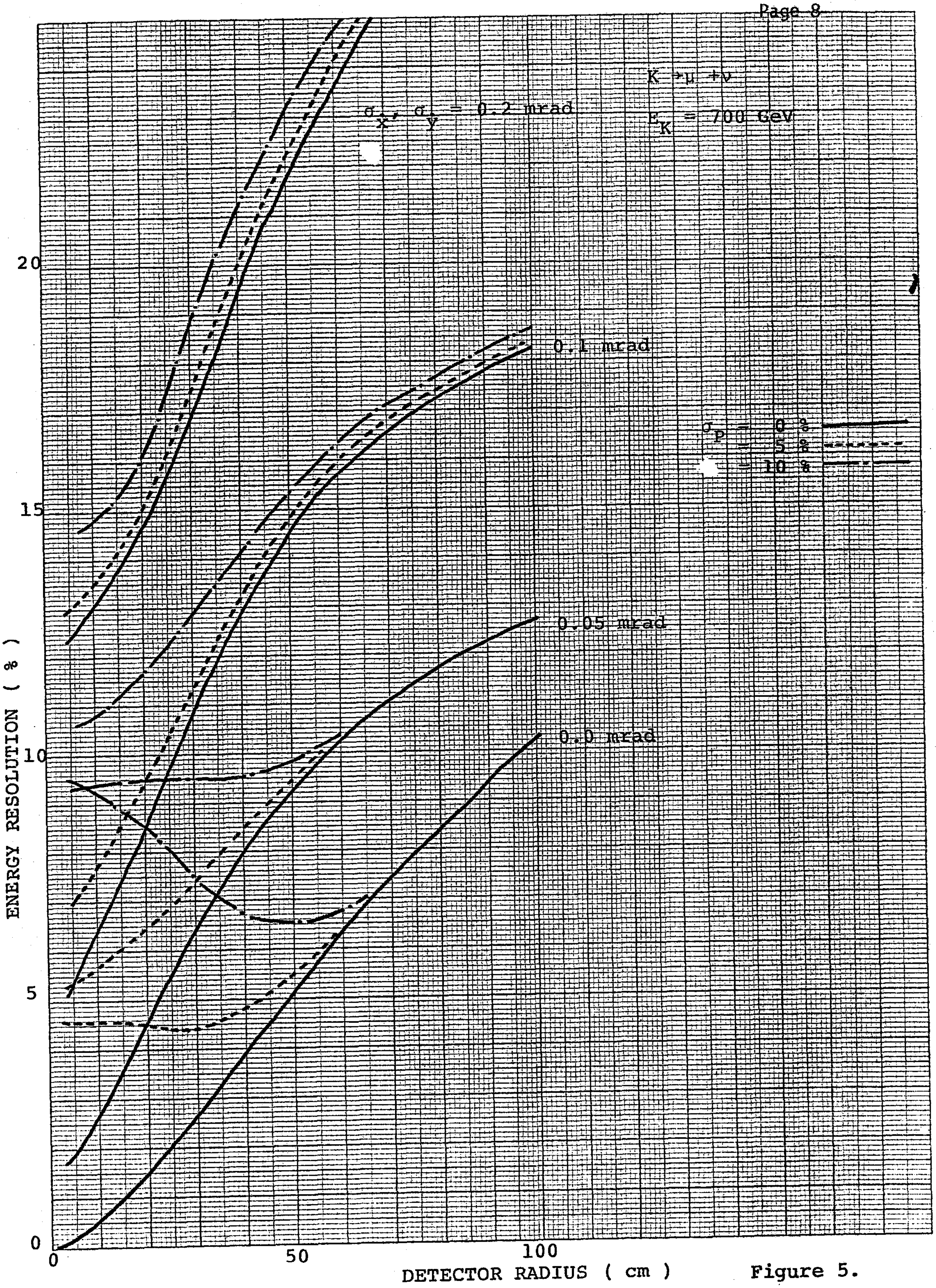

$K \to \mu + \nu$
E_K = 700 GeV
$\sigma_{x'}, \sigma_{y'}$ = 0.2 mrad
0.1 mrad
0.05 mrad
0.0 mrad
σ_P = 0 %
= 5 %
= 10 %
ENERGY RESOLUTION (%)
0
5
10
15
20
0
50
100
DETECTOR RADIUS (cm)

Figure 5.